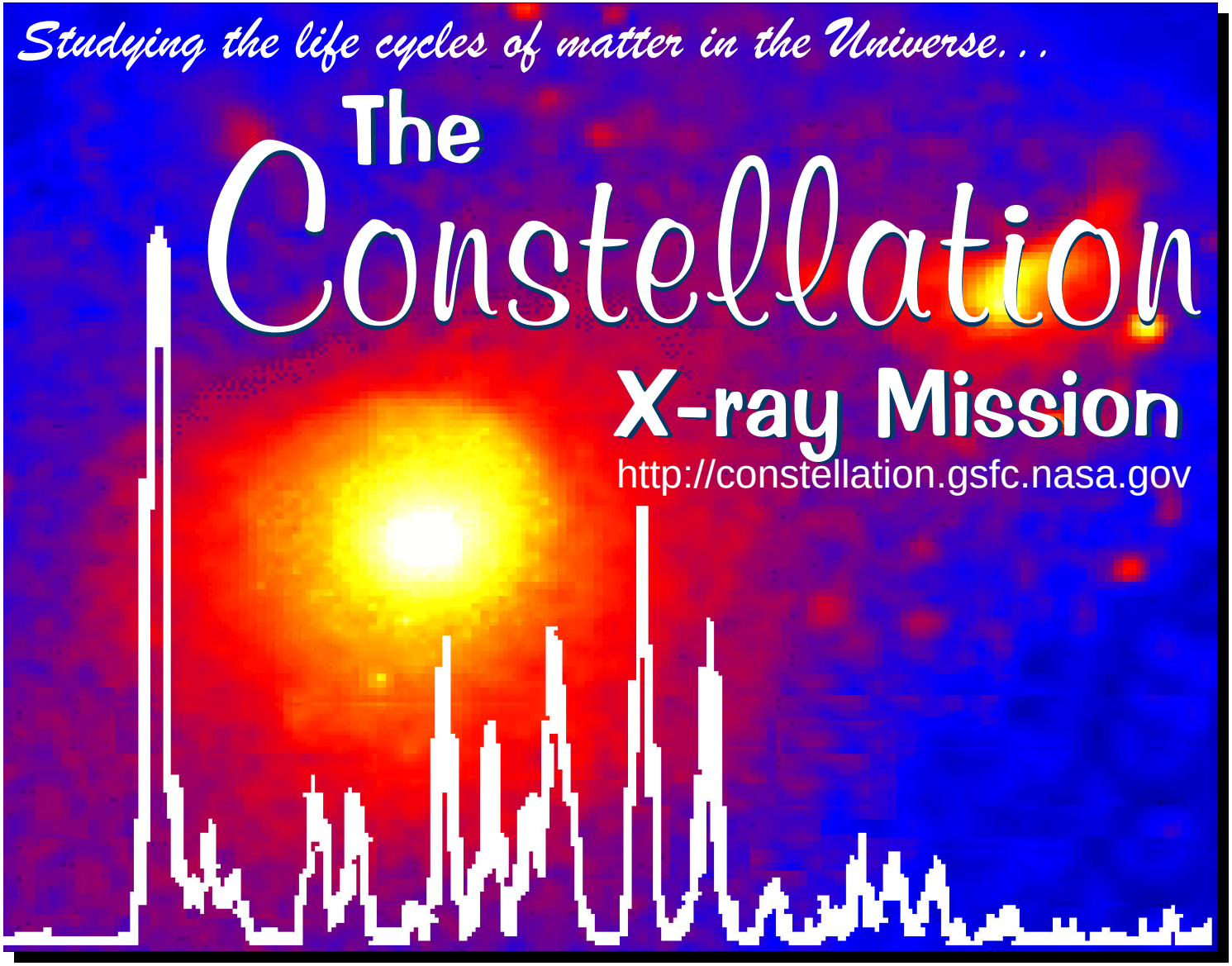
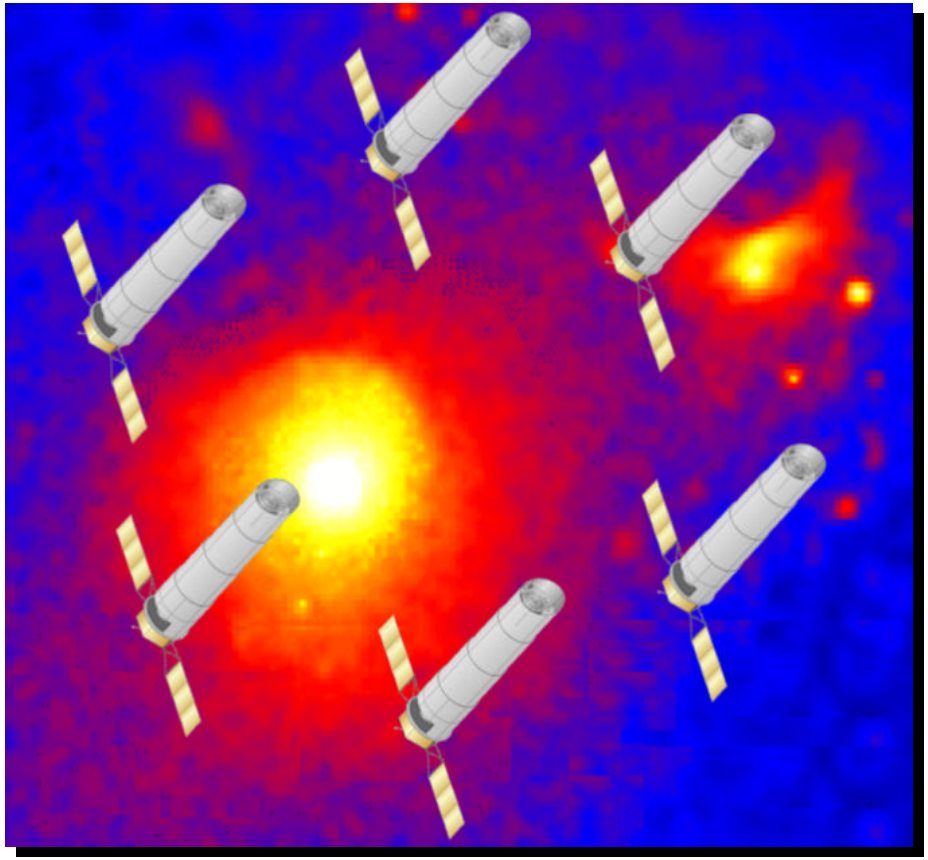
The Constellation X-ray Mission



The Constellation X-ray Mission

Studying the life cycles of matter in the Universe



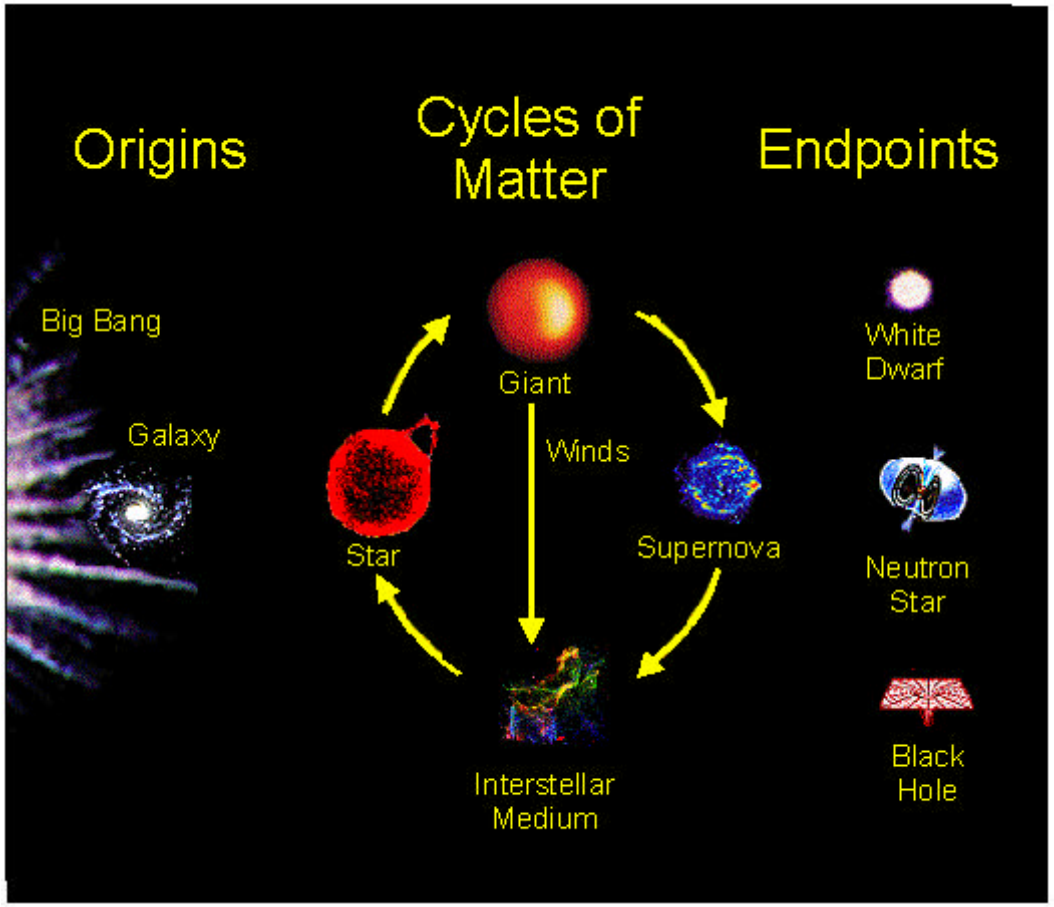
Constellation-X

- Key scientific goals
  - Elemental abundances and enrichment processes throughout the Universe
  - Parameters of supermassive black holes
  - Plasma diagnostics from stars to clusters
- Mission parameters
  - Effective area: 15,000 cm^2 at 1 keV
    100 times AXAF and XMM for high resolution spectroscopy
  - Spectral resolving power: 3,000 at 6.4 keV
    5 times Astro-E calorimeter
  - Band pass: 0.25 to 40 keV
    100 times increased sensitivity at 40 keV

Studying the Life Cycles of Matter with Constellation-X

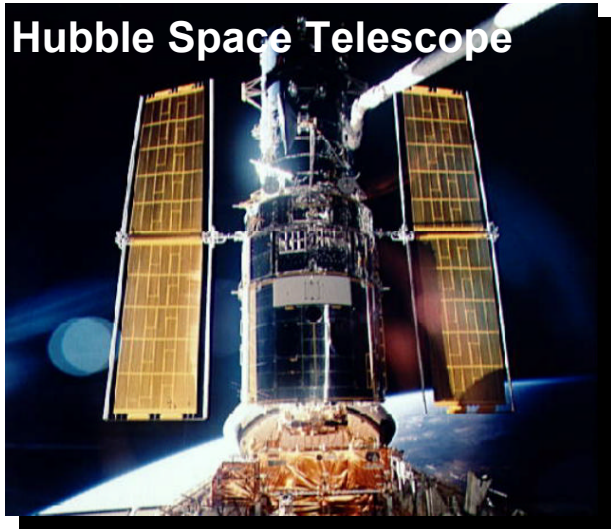
Obtain high quality X-ray spectra for all classes of X-ray sources over a wide range of luminosity and distance to determine:

- **the abundance of elements with atomic number between Carbon and Zinc (Z=6 to 30) using line to continuum ratios**
- **the ionization state, temperature, and density of the emission region using plasma diagnostics**
- **the underlying continuum process with a broad bandpass**
- **dynamics from line shifts and line broadening**

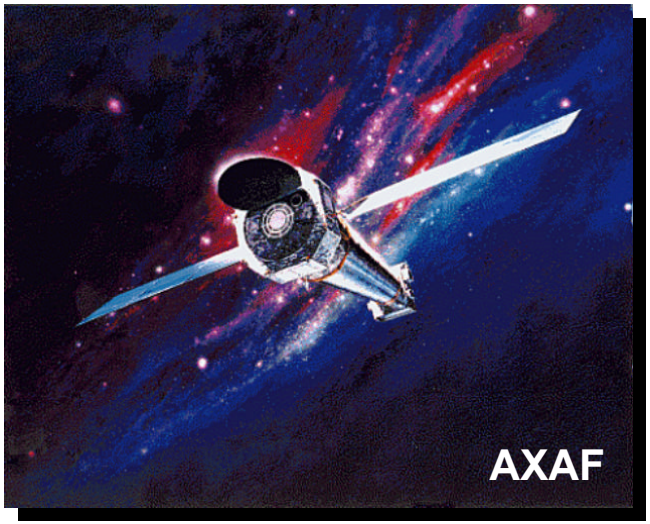


X-ray Equivalent of the Keck Telescope

Imaging



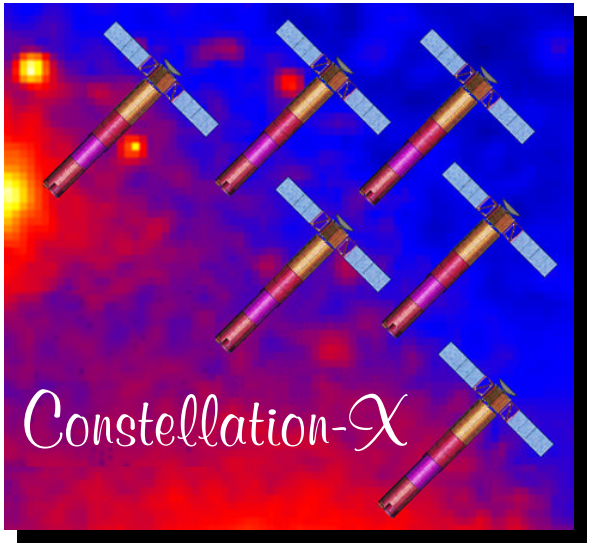
0.1 arc sec
40,000 cm^2



0.6 arc sec
1,000 cm^2
(100 cm^2)*

Spectroscopy

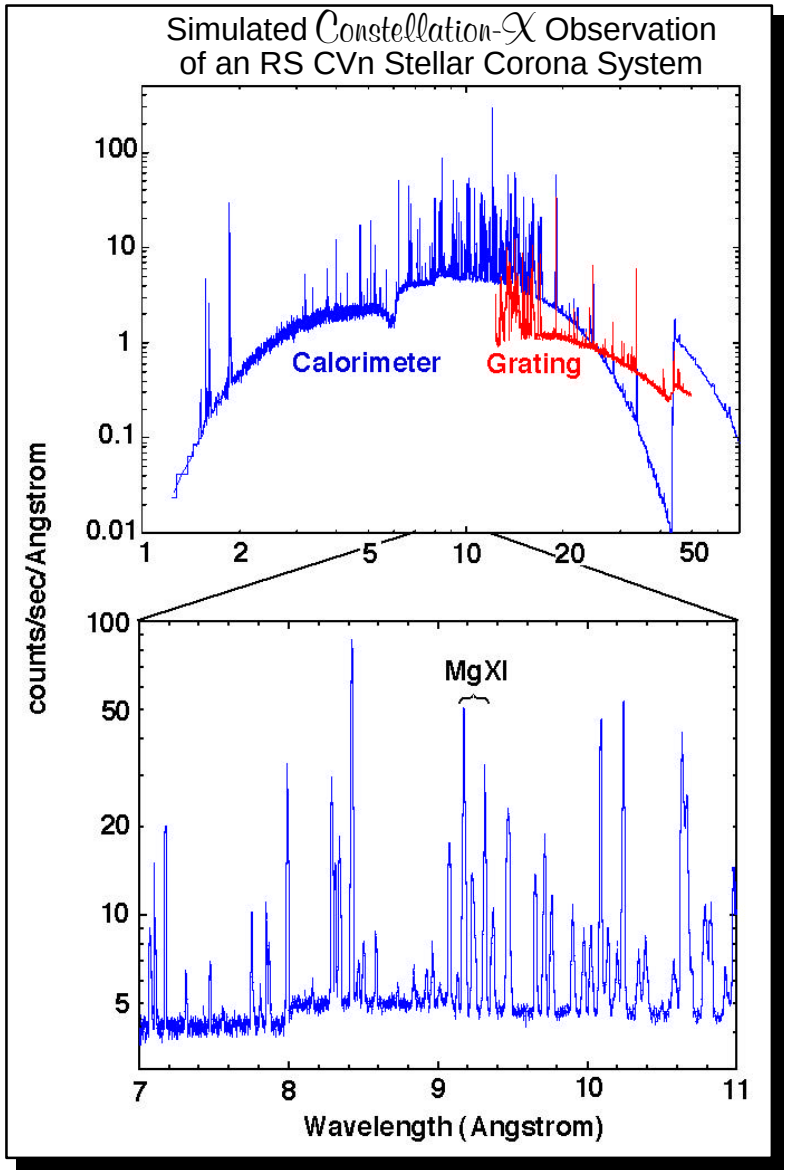
1 arc sec
780,000 cm^2



15 arc sec
30,000 cm^2
(15,000 cm^2)*

* effective area at the spectrometer

Abundance Determinations



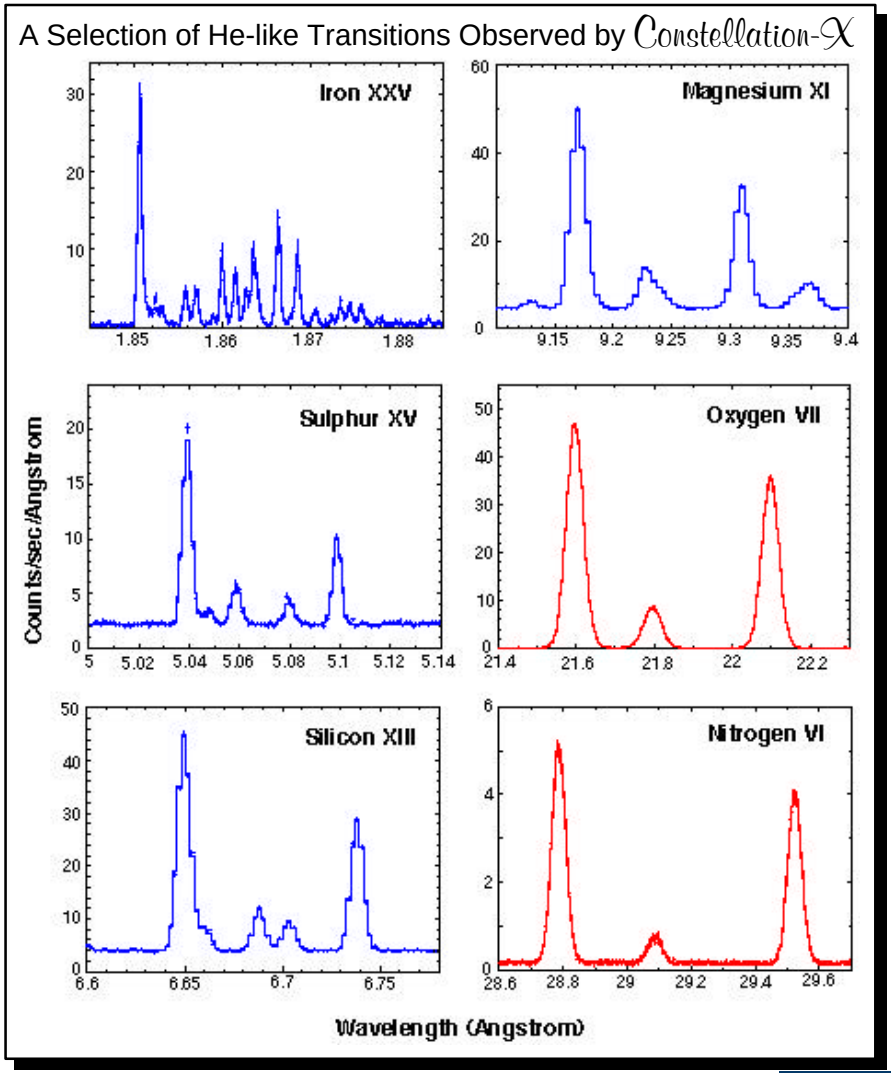
The Constellation-X energy band contains the K-line transitions of 25 elements allowing simultaneous direct abundance determinations using line-to-continuum ratios

The sensitivity of Constellation-X will allow abundance measurements in:

- the intracluster medium in distant clusters,
- the halos of elliptical galaxies,
- starburst galaxies,
- stellar coronae,
- young and pre-main sequence stars,
- X-ray irradiated accretion flows, and
- supernova remnants and the interstellar medium.

Temperature, Density, and Velocity Diagnostics

The spectral resolution of the Constellation X-ray Mission is tuned to study the He-like density sensitive transitions of Carbon through Zinc



Direct determination of

- densities from 10^8 to 10^{14} cm^{-3}
- temperature from 1-100 million degrees.

Velocity diagnostics at Fe K line:

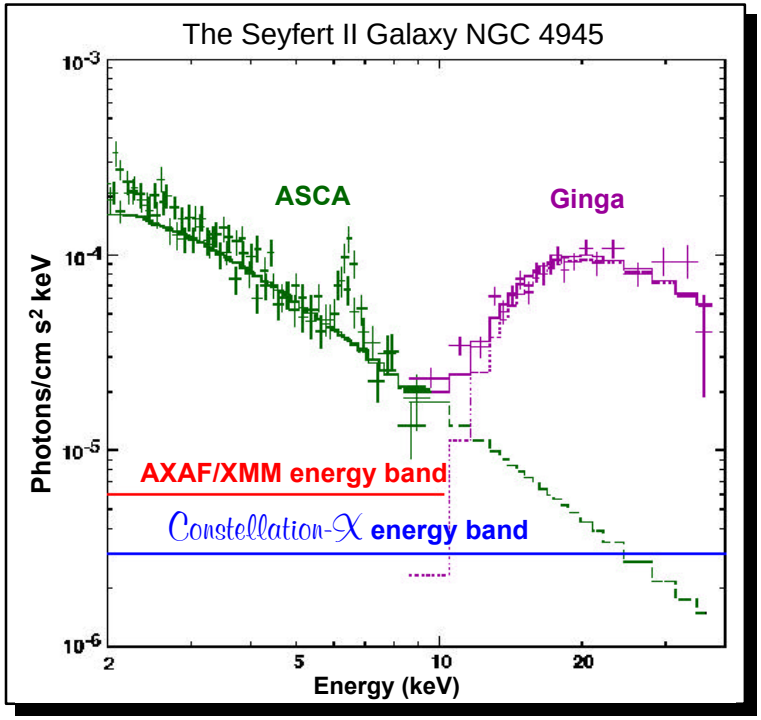
- line width gives a bulk velocity of 100 km/s
- line energy gives an absolute velocity determination to 10 km/s

Simultaneous determination of the continuum parameters

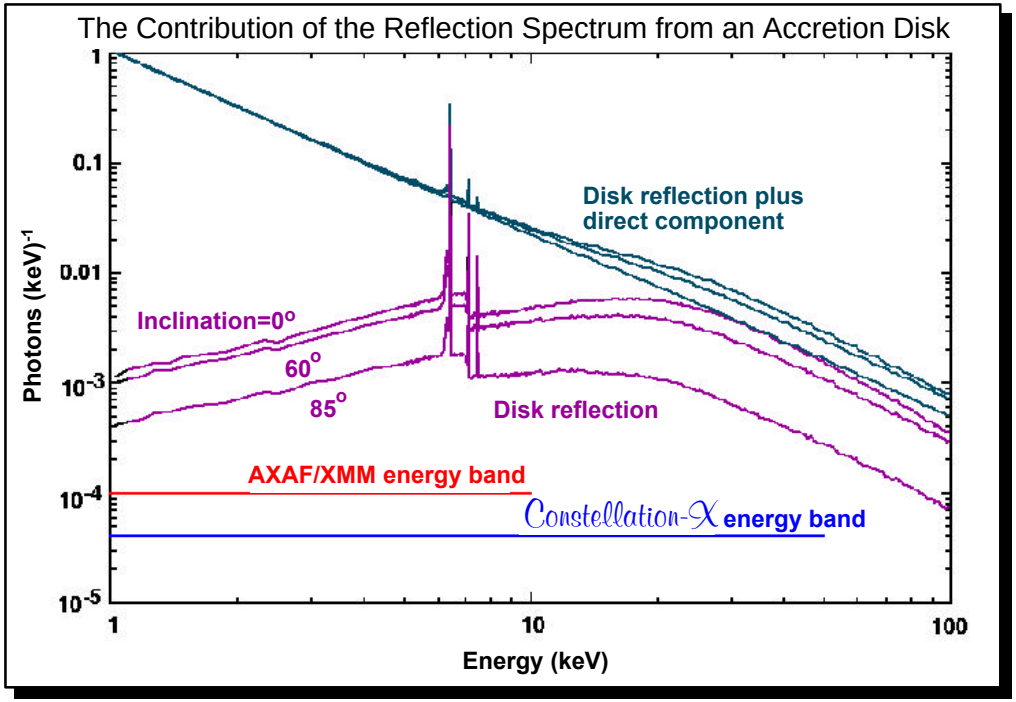
Hard X-ray Capability

The hard X-ray band is crucial to determine the underlying continuum

Planned missions (AXAF, AMM, Spectrum XG, and Astro-E) have limited or no sensitivity above 10 keV



AGN viewed edge-on through the molecular torus

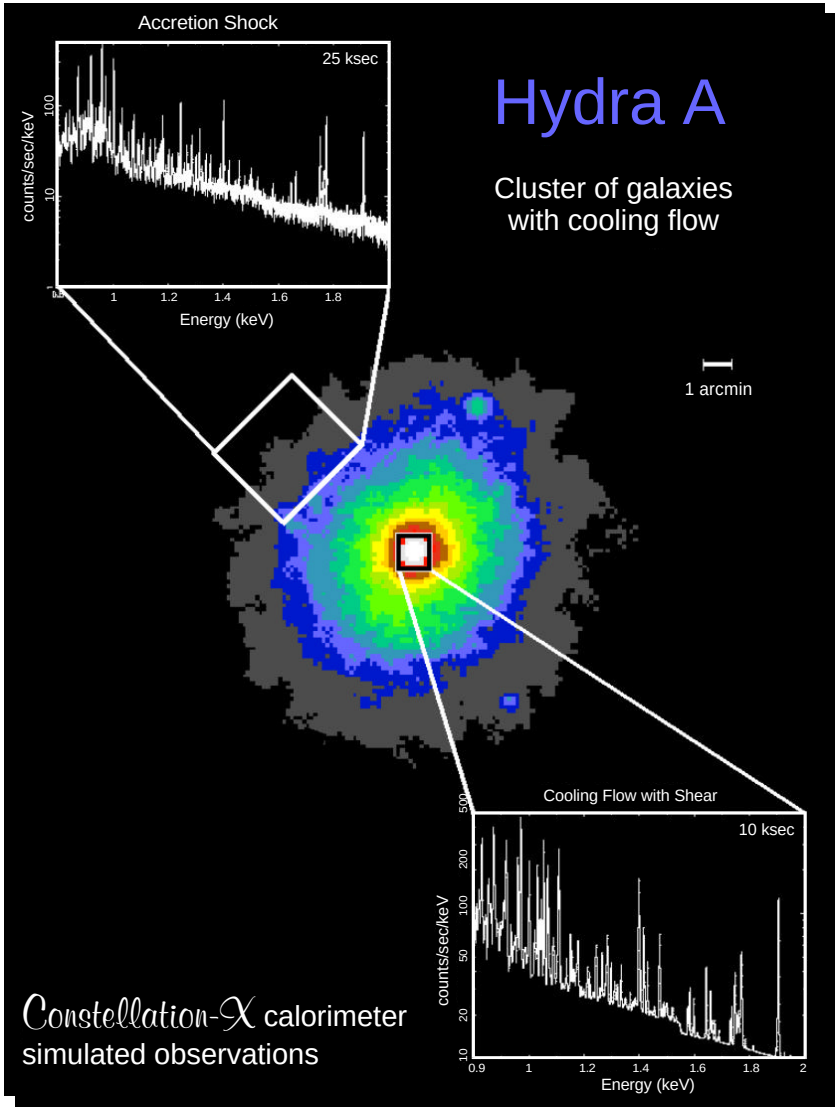


AGN viewed face-on

- **No previous instrument has employed focusing in the Hard X-ray band**
- **Multilayer coatings and hard X-ray pixelated detectors to increase high energy response**
- **Dramatic sensitivity improvements will be achieved**

Observations of Clusters of Galaxies

Baryon content of Universe is dominated by hot X-ray emitting plasma

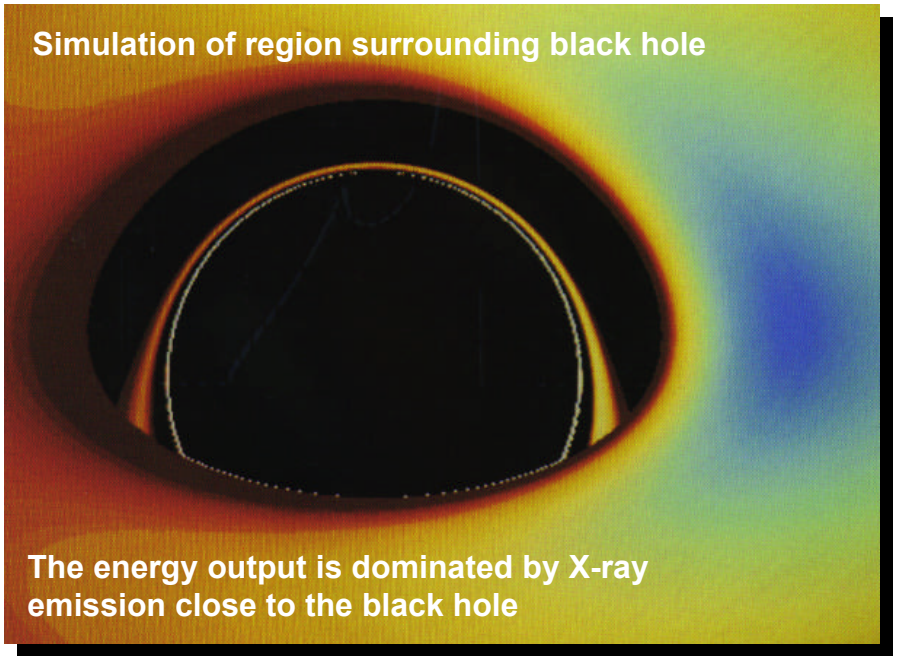


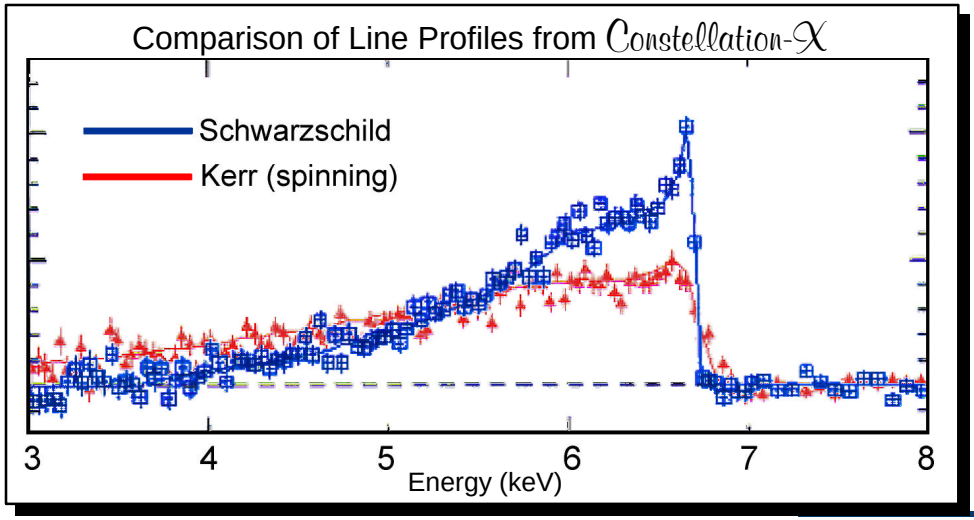
Clusters of galaxies are the largest and most massive objects known

Constellation-X observations of clusters essential for understanding structure, evolution, and mass content of the Universe

- Observe epoch of cluster formation and determine changes in luminosity, shape, and size vs redshift
- Measure abundances of elements from carbon to zinc, globally mapping generation and dissemination of seeds for earth-like planets and life itself
- Map velocity profiles, probing dynamics and measuring distributions of luminous and dark matter

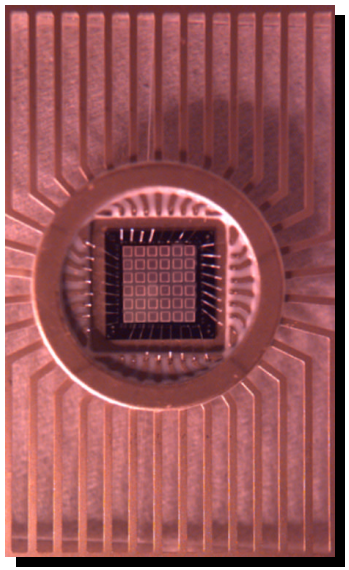
Constellation-X Will Determine the Nature of Supermassive Black Holes



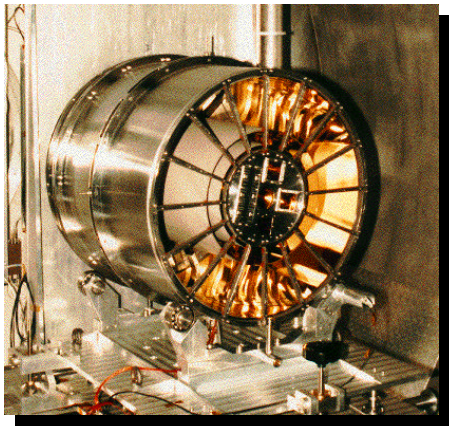


- **Active galactic nuclei and quasars powered by accretion of matter onto supermassive black holes**
- **X-rays produced near event horizon and probe 100,000 times closer to black hole than HST**
- **Relativistically broadened iron lines probe inner sanctum near black holes, testing GR in strong gravity limit**
- **Constellation-X will determine black hole mass and spin using iron K line**
  - Spin from line profiles
  - Mass from time-linked intensity changes for line and continuum

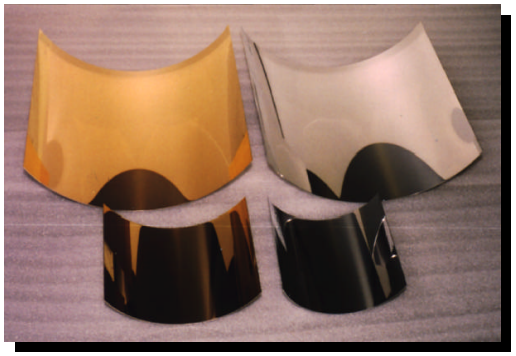
Constellation-X Technology Requirements



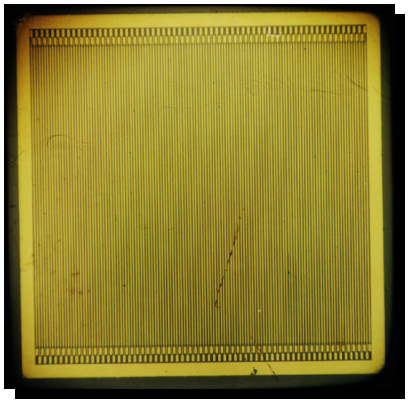
Microcalorimeters



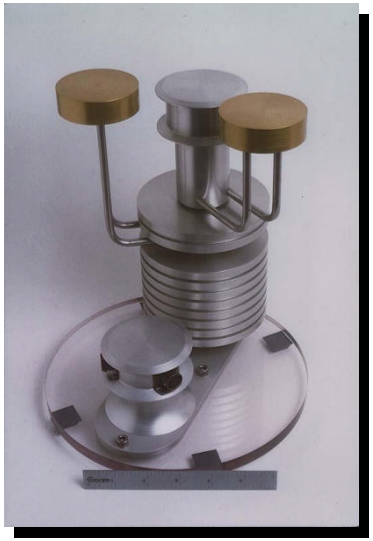
Lightweight
X-ray Optics



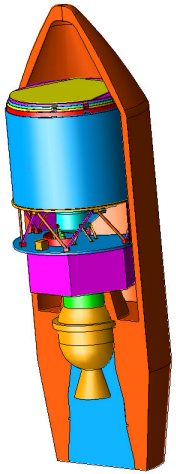
Multilayer Coatings

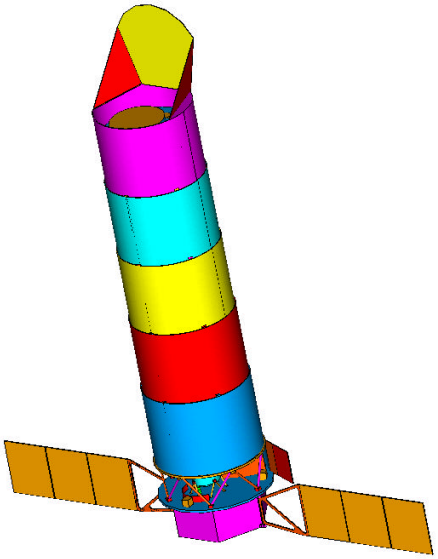


CdZnTe Arrays

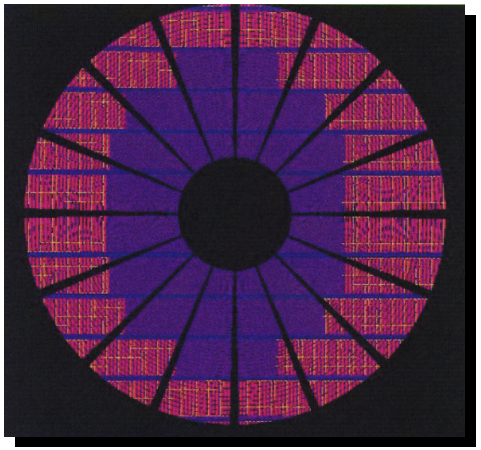


Coolers





Deployable Structures



CCD/Grating

X-ray Observatories Timeline

Constellation-X

Upcoming Missions:

AXAF
Spectrum XG
XMM
Astro-E

Current Missions:

ROSAT
ASCA
RXTE
BeppoSAX

1996 1998 2000 2002 2004 2006 2008 2010